TROITSKIY, V.S.

Radio astronomical method for measuring antenna losses. Zhur. tekh.fiz.26 no.2:485-486 F '56. (MLRA 9:6)
(Antennas (Electronics)) (Radio astronomy)

TROITSKIY, V.S

112-1-2188

Translation from: Referativnyy Zhurnal, Elektrotekhnika, 1957, Nr 1, p. 325 (USSR)

AUTHORS: Troitskiy, V.S., Rakhlin, V.L.

TITLE: Absolute Microwattmeter for a 3.2-cm Wave and its Application in Radio-astronomy and Engineering (Absolyutnyy mikrovattmetr na volnu 3.2 cm i yego primeneniye v radioastronomii i tekhnike)

PERIODICAL: Uch. zapiski Gor'kovsk. un-t, 1956, 30, pp.83-91.

ABSTRACT: In the described wattmeter the measured power is compared by the zero method with a standard power; as such the radio emission of a heated matched absorber placed inside a waveguide is used. Its radio-emissive capacity is determined by its absolute temperature. The systematic error in measuring the power of a sinusoidal signal does not exceed ±7 per cent. In measuring noise capacity with a smooth

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112-1-2188

Absolute Microwattmeter for a 3.2-cm Wave (Cont.)

spectrum, the error is reduced to ± per cent, because in that case the transmission band does not enter into the wattmeter's constant. The heating up of the sample and obtaining a wide transmission band involve difficulties. In the described wattmeter the sample was heated up to 200° which added about 3 10^{-14} watt to the standard capacity. Powers up to 10^{-11} watt can be measured by the zero method with an accuracy of ± 10 per cent; in this method a matched absorber having regular room temperature instead of the standard, is connected at the input. The instrument is first of all calibrated according to the difference of capacities of the cold and hot standards after which the gain in it is reduced for a determined number of times. The lowest capacity which can be measured with the wattmeter is determined from the level of its own noises, causing a chaotic movement of the output device's indicator; this capacity amounts to 10^{-16} watts for the instrument being described. In measuring capacities over 10^{-13} w, its fluctuation error does not exceed 0.1 per cent. Also, other possible sources of error are investigated, as well as measures for their prevention. In the described wattmeter these additional errors are reduced so much that it can be used for

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Absolute Microwattmeter for a 3.2-cm Wave (Cont.) 112-1-2188

measuring capacities of the order of 10^{-15} w with an accuracy of $\pm$ 10 per cent. The wattmeter is designed for measuring capacities of a monochromatic signal with a 9375 Mc frequency or a signal with a continuous spectrum in a band of about 10 Mc around the same frequency, and also an average pulse power with a pulse frequency band not exceeding 5 Mc, and pulse capacity not above 10^{-11} watt. Utilizing standard horns one can apply the device for precision measurements of field strength. The more important fields of application of the wattmeter are measurements of radio emission of cosmic bodies and of noise of various types of electronic devices. Bibliography: 7 titles.

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A.S.B.

TROITSKIY, V.S.

109-7-12/17

AUTHOR: Troitskiy, V.S.

TITLE: The Problem of Thermo-calibration of Radio-astronomical Equipment. (K voprosu o teplovoy kalibrovke radioastronomicheskoy apparatury) (Brief news item)

PERIODICAL: Radiotekhnika i Elektronika, 1957, Vol. II, No.7, pp. 935 - 937 (USSR)

ABSTRACT: Thermo-calibration of a radio-astronomical receiver usually requires at least three measurements. The procedure can be simplified by adopting the following method. The antenna of the receiver is directed vertically, in which case the temperature of the antenna is expressed by:

$$T_{aH} = T_{\varkappa}(1 - \gamma) + \gamma T_o \quad (4)$$

where T_o is the temperature of the material of the antenna; γT_o is the temperature of the antenna noise and $T_{\varkappa}$ is the temperature of the vertical region of the sky. The measuring equipment is then switched over from the antenna to a "cold" standard and T_{aH} is determined from the deflection of the measuring equipment which is given by:

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The Problem of Thermo-calibration of Radio-astronomical Equipment.

$$\beta_{\varkappa} = \alpha \left| T_o - T_{aH} \right| \quad (5)$$

The temperature of the antenna is then expressed by:

$$T_e = \frac{\beta_c}{\beta_{\varkappa}} \left| T_o - T_{\varkappa} \right| \quad (7)$$

where the quantity $T_{\varkappa}$ should be known and can assume any value not equal to T_o. The above method of measurement is being used at the Gorkiy Radio-astronomical Station for the measurement of the intensity of the cosmic sources at cm waves. There are 6 references, 3 of which are Slavic.

ASSOCIATION: Radio-physics Institute of the Gorkiy University. (Radiofizicheskiy Institut pri Gor'kovskom Universitete)

SUBMITTED: June 26, 1956

AVAILABLE: Library of Congress.

Card 2/2

TROITSKIY, V. S.

AUTHOR: Troitskiy, V.S,

"Theory of the Molecular Generator and Fluctuation of Its Oscillation," A-U Sci Conf dedicated to Radio Day," Moscow 20-25 May 1957.

PERIODICAL: Radiotekhnika i Elektronika, Vol. 2, No. 9, pp. 1221-1224, 1957, (USSR)

SOV/35-59-8-6344

Translation from: Referativnyy zhurnal, Astronomiya i Geodeziya, 1959, Nr 8, p 35

AUTHORS: Troitskiy, V.S., Zelinskaya, M.R., Rakhlin, V.L., Bobrik, V.T.

TITLE: Results of Observations of the Solar Radio-Frequency Emission at Wave-lengths of 3.2 and 10 cm During the Total Sun's Eclipse on February 25, 1952, and June 30, 1954

PERIODICAL: V sb.: Polnyye solnechn. zatmeniya 25 fevr. 1952 i 30 iyunya 1954, Moscow, AS USSR, 1958, p 330

ABSTRACT: See RZhAstr, 1957, Nr 1, p 489.

Card 1/1

[illegible] (NIRFI, Gor'kiy)

"The Influence of Spontaneous Radiation on the Spectral Line Width of a Molecular Generator".

He considered the influence of spontaneous radiation of excited molecules in a generator network. The author showed that the spontaneous molecule radiation leads to # a widening of spectral lines in existing generators.

report presented at the All-Union Conference on Statistical Radio Physics, Gor'kiy, 13-18 October 1958. (Izv. vyssh uchev zaved-Radiotekh., vol. 2, No. 1, pp 121-127) COMPLETE card under SIFOROV, V. I.)

TROITSKIY, V. S., TSAREGRADSKIY, V. B. (NIRFI, Gor'kiy)

"The Sensitivity of Amplifiers Working on a Beam of Excited Molecules".

The authors showed that the influence of thermal network noise on the receiver sensitivity may be changed by parameters dubject to selection, but the spontaneous molecule radiation noise increases in this case. At room temperature and optimum parameters, the interior noise of such an amplifier will amount to about 8° Kelvin.

report presented at the All-Union Conference on Statistical Radio Physics, Gor'kiy, 13-18 October 1958. (Izv. vyssh uchev zaved-Radiotekh., vol. 2, No. 1, pp 121-127) COMPLETE card under SIFOROV, V. I.)

TROITSKIY, V.S. (NIRFI, Gor'kiy)

"The Spectral Width of Tube Oscillator Lines and Flicker Noise."

Explains method for calculating the influence of slow fluctuations on the frequency and amplitude of self-oscillator oscillations. Showed that tube flicker noise may influence the amplitude and frequency fluctuation of the oscillations, whereby the line contour appears in the Doppler shape, while its width by some orders.

report presented at the 1st All-Union Conference on Statistical Radio Physics, Gor'kiy, 13-18 October 1958. (Izv. vyssh ucheb zaved-Radiotekh., vol. 2, No. 1, pp 121-127) COMPLETE card under SIFOROV, V. I.)

TROITSKIY, V. S., M. P. ZELINSKAYA, V. L. RAKHLIN, V. T. BOBRIK

"Results of Observation of Solar Radio Emissions in the 3.2 and 10 cm Wave length During the Total Solar Eclipse of February 25, 1952 and June 30, 1954"

(Total Eclipse of the Sun, February 25, 1952 and June 30, 1954, Transactions of the Expedition to Observe Solar Eclipses) Moscow, Izd-vo AN SSSR, 1956. 357 p.

06513 SOV/141-58-1-3/14

AUTHOR: Troitskiy, V. S.

TITLE: Some Problems of the Noise Theory in Oscillators. Influence of the Flicker Noise.

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1958, Nr 1, pp 20-33 (USSR)

ABSTRACT: The fundamentals of the noise theory in the oscillations produced by vacuum tubes were laid down by Bershteyn in 1938 (Ref 1). The equation of the oscillator constructed by Bershteyn took into account the thermal noise $\xi_o(t)$ of the resonant circuit and the shot noise $\xi_1(t)$ of the tube. This is in the form of Eq (1), where μ is a small parameter and D_o and D_1 are certain linear integral differential operators. Further work on the noise in the oscillators was done by Gorelik (Ref 3) and by Rytov (Ref 4). The investigation of the spectrum of the oscillators was not considered by the above investigators. It was first studied by Middleton (Ref 5) and later by others (Refs 6 and 7). It appears however that

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Some Problems of the Noise Theory in Oscill:tors. Influence of the Flicker Noise

averaging of Eq (3) over a period re:ults in Eqs (4), where A_1 and B_1 are defined by Eqs (5). In the absence of the fluctuations the solution of Eqs (4) gives a quantity a_o for the amplitude and ϑ_1 for the p:ase. In the presence of the fluctuations a random amplitude :omponent $\alpha(t)$ and a random phase $\varphi(t)$ are produced. T:ese can be determined from Eqs (7). If the spectrum of th: oscillations is comparatively narrow, Eqs (7) can be wr:tten as:

$$\frac{da}{dt} = p\alpha - \frac{1}{a_o\omega_o}\xi(t) \sin \omega_1 t \,, \tag{8}$$

$$\frac{d\varphi}{dt} = qa_o\alpha - \frac{1}{a_o\,\omega_o}\xi(t) \cos \omega_1 t \,.$$

These can also be written as Eqs (9:. The amplitude spectrum of the fluctuations is given by Eq :12) while the frequency

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spectrum is defined by Eq (13), where $\Delta = qa_o$ and $w_\xi(\omega)$ is the spectrum of the function $\xi(t)$. The symbol Ω denotes the frequency $\omega_1 - \omega$, where ω_1 is the oscillation frequency in the absence of fluctuations. Since the expression for w_ξ depends on the type of the oscillator, it is seen that the fluctuation spectrum will also be a function of the circuit. For an anode-tuned oscillator, the amplitude and frequency spectra are given by Eqs (15), where P is the power of the oscillator and I_2 is the amplitude of the first harmonic of the anode current. The above expressions assume that the noise is a stationary random process. Normally, this assumption is not valid, since the shot noise and the flicker noise vary periodically. This variation can be represented by defining the average square value of the total noise current. This is given by the first equation on p 27. The basic equations can now be written as Eqs (17) and (18). The amplitude spectrum is given by Eq (21), which in its final form can be represented by Eq (23). The final formula for the

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Some Problems of the Noise Theory in Oscillators. Influence of the Flicker Noise

frequency spectrum is in the form of Eq (26). From Eq (26) it can be seen that the flicker noise has a direct effect on the frequency fluctuations. The above formula can be used to investigate an anode-tuned oscillator which contains a special quadripole in its grid producing a phase shift r . The effect of the flicker noise on the frequency spectrum in this case is represented by Eq (30). The analysis shows that the spectrum of the amplitude fluctuation at low frequencies is almost entirely determined by the spectrum of the flicker noise. On the other hand, the frequency fluctuation is due to the flicker noise only when there exists a phase shift between the anode current and the load voltage. Furthermore, the width of the spectral line is independent of the power produced by the generator and is a function of the parameters

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SOV/141-58-1-3/14

Some Problems of the Noise Theory in Oscillators. Influence of the Flicker Noise

of the network and the flicker noise of the tube. The author expresses his gratitude to I. L. Bershteyn and G. S. Gorelik for their interest in this work and to A. N. Malakhov for valuable remarks. The paper contains 1 figure and 19 references, 16 of which are Soviet and 3 English.

ASSOCIATION: Issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Radio-Physics Research Institute of Gor'kiy University)

SUBMITTED: October 5, 1957.

Card 6/6

ZHEVAKIN, S.A.; TROITSKIY, V.S.; TSEYTLIN, N.M.

Atmospheric radio emission and investigation of absorption of centimeter radio waves. Izv.vys.ucheb.zav.; radiofiz. 1 no.2: 19-26 '58. (MIRA 11:11)

1.Issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete.
(Microwaves) (Atmosphere)

SOV-109-3-4-26/28

AUTHOR: Troitskiy, V. S.

TITLE: Discussion: Remarks on the Article of V. I. Tikhonov and I. N. Amiantov - "Influence of Slow Fluctuations on an Oscillator" (Diskussii: O stat'ye V. I. Tikhonova i I. N. Amiantova - "Vozdeystviye medlennykh flyuktuatsiy na avtogenerator")

PERIODICAL: Radiotekhnika i Elektronika, 1958, Vol 3, Nr 4, pp 579-580 (USSR)

ABSTRACT: The paper under the above title was published in this journal in April, 1956, pp 428-432. Here, it is pointed out that Eq.(3) quoted by Tikhonov and Amiantov does not satisfactorily describe the problem in view of the fact that their Eq.(2) for the characteristic of the tube is incorrect. It is shown that the principal equation should be in the form:

$$\ddot{x} + \dot{x} = \mu_0 \left[1 - \left(x - \frac{D}{k - D} \zeta \right)^2 \right] \dot{x} \quad . \qquad (V)$$

It is further pointed out that the problem of frequency fluctuations in an electron tube oscillator cannot be

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SOV-109-3-4-26/28

Discussion: Remarks on the Article of V. I. Tikhonov and I. N. Amiantov - "Influence of Slow Fluctuations on an Oscillator"

analysed by considering the fluctuation of the tube current characteristic alone. It is thought that the main reason for the frequency fluctuation is the change of internal dynamic capacitances of the tube which are caused by the changes of the space charge. The note contains 2 Soviet references.

SUBMITTED: April 12, 1957

1. Electron tube oscillators--Mathematical analysis 2. Electron tube oscillators--Performance 3. Electron tube oscillators--Theory

Card 2/2

AUTHOR: Troitskiy, V.S. SOV/109-3-10-9/12

TITLE: The Theory of Molecular (Maser) Oscillator and (the Theory of) the Fluctuation of its Oscillations (K teorii molekulyarnogo generatora i fluktuatsiy ego kolebaniy)

PERIODICAL: Radiotekhnika i Elektronika, 1958, Vol 3, Nr 10, pp 1298 - 1313 (USSR)

ABSTRACT: It is assumed that the voltage at the condenser of the oscillator is sinusoidal, so that its operation can be described by the Basov-Prokhorov equation (Ref 1):

$$\frac{d^2 v}{dt^2} + \frac{\omega_0}{Q}\frac{dv}{dt} + v\frac{\omega_0^2}{\vec{\varepsilon}} = 0 \qquad (1)$$

where Q is the quality of the circuit, ω_0 is the natural frequency of the resonant circuit in the absence of the molecules, V is the voltage on the condenser, while L, C and r are the parameters of the resonant circuit; the complex permittivity $\vec{\varepsilon} = \varepsilon_1(\omega, E_0) - i\varepsilon_2(\omega, E_0)$ corresponds to the steady-state frequency and amplitude of

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The Theory of Molecular (Maser) Oscillator and (the Theory of) the Fluctuation of its Oscillations

the field across the condenser, i.e. $E_0 = A_0/a$. Eq.(1) does not, strictly speaking, describe the transient processes, but if the processes are comparatively slow, it can also be used in the transient analysis. The fluctuations of amplitude and phase of the oscillations in the generator are caused by the electromotive force $\xi(t)$ of the thermal noise current which has a spectral density ω_ξ, and by the shot effect of the molecules. By taking $\xi(t)$ into account, Eq.(1) is transformed into Eq.(2). If it is assumed that the solution of Eq.(2) is in the form of $V = A \cos \theta$, where $A = A(t)$ and $\theta = \theta(t)$, the equation can be written in the form of Eqs.(3), in which Φ and Ψ are expressed by Eqs.(4) and (5), respectively. Eqs.(3) are the basic expressions for the analysis of the system. First, the effect of the discontinuous nature of the permittivity of the system is investigated. It is shown that if the molecular beam is mono-kinetic, the two components of the permittivity can be expressed by Eqs.(8), where M is the number of molecules in the condenser at

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a given instant, S is the cross-section of the molecular beam and l is the path in the condenser. In reality, the molecular beam is not mono-kinetic and its distribution function can be approximately represented by Eq.(9), where τ_0 is the most probable value of the transit time of the molecules. On the basis of this distribution, the two permittivity components are expressed by Eqs.(10). The fluctuations of ε_1 and ε_2 are dependent on the fluctuation of M. If $M(t) - \bar{M} = m(t)$ and if $N(t)$ represents the velocity of the molecular beam, ε_2 and ε_1 can be written as Eqs.(11) and their average values are given by Eqs.(12). The spectral density of $m(t)$ is given by Eqs(14) for a mono-kinetic, molecular beam and by Eq.(15) for a non-mono-kinetic beam. In the absence of the amplitude and phase fluctuations, Eqs.(3) can be written in the form of Eqs.(16), from which the condition of self-excitation is expressed by Eq.(18). On the other hand, Eq.(17) gives the frequency of oscillation; the

equation can be written in the form of Eq.(20) where Δ^2 is defined by Eq.(19) and $v = (\omega_2 - \omega_o)\tau_o$ and $R = \omega_2\tau_0/2Q$. Eq.(20) is plotted in Figure 3 as a function of u for various values of η and $R\eta/v$. It is shown that the oscillations are stable in amplitude provided:

$$\frac{d\Phi_1}{dA_o} = p_o < 0 .$$

On the basis of Eqs.(24), it is found that p_o can be expressed by Eq.(26). The equation is employed to determine the boundaries of the stable region of operation and these are shown in Figure 4; the vertically shaded areas correspond to the unstable region, while the horizontally shaded areas represent a stable region of operation. The fluctuations of the amplitude and phase of the system can be described by Eqs.(29). If

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The Theory of Molecular (Maser) Oscillator and (the Theory of) the Fluctuation of its Oscillations

$A = A_0 + A_0\alpha(t)$ and $\dot{\theta} = \omega = \omega_1 + \dot{\varphi}(t)$, Eqs.(29) can be written as Eqs.(30) and (31). On the basis of these equations, the frequency and amplitude fluctuations are finally described by Eqs.(33). These can be written in the final form, as given by Eqs.(36) and (37), respectively. Eq.(36) can be solved by the Fourier method and gives the following expression for the spectral density of the frequency fluctuations:

$$w_\nu(\Omega) = \frac{1}{(1 - q_1)^2}\left\{\overline{3}Nq_2^2 \frac{\Omega^2}{p_0^2 + \Omega^2} + \frac{w_\xi(\Omega,\omega_1)\omega_1}{2A_0^2} \frac{p^2 + \Omega^2}{p_0^2 + \Omega^2} + \right. \tag{38}$$

$$\left. + \frac{w_\xi(\Omega,\omega_1)}{2}\omega_1^2 \frac{q_1}{p_0^2 + \Omega^2} + \frac{w_\xi(\Omega,\omega_1)\omega_1^2}{A_0} \frac{q\Omega}{p_0^2 + \Omega^2}\right\} .$$

Similarly, the spectral density of the amplitude fluctuations

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The Theory of Molecular (Maser) Oscillator and (the Theory of) the Fluctuation of its Oscillations

is expressed by Eq.(39); alternatively, the two equations can be written in the form of Eqs.(40) and (41). Eq.(40) is used to determine the width of the spectral line of the oscillator and this is equal to:

$$\Delta F = \frac{w_\nu(0)}{4\pi} = \frac{1}{4\pi}\,\frac{kT}{P}\,.\,\frac{\omega_2^2}{Q_1^2}\,(1 + u^2) \qquad (45)\,.$$

On the basis of Eq.(45), it is found that the fluctuation for an oscillator based on ammonia is $\Delta F = 10^{-4}$ cps; this value is lower by several orders than the corresponding value for a vacuum-tube oscillator.
There are 7 figures and 10 references, 8 of which are Soviet and 2 English.

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SOV/109-3-10-9/12

The Theory of Molecular (Maser) Oscillator and (the Theory of) the Fluctuation of its Oscillations

ASSOCIATION: Radiofizicheskiy institut pri gosudarstvennom universitete im. N.I. Lobachevskogo, g. Gor'kiy (Radio-physics Institute at the State University im. N.I. Lobachevskiy, Gor'kiy)

SUBMITTED: March 14, 1957

1. Microwave oscillators--Theory

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56-2-17/51

AUTHOR: Troitskiy, V.S.

TITLE: A Contribution to the Theory of the Molecular Generator and of the Fluctuations of its Vibrations (K teorii molekulyarnogo generatora i fluktuatsiy yego kolebaniy)

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958, Vol 34, Nr 2, pp 390-393 (USSR)

ABSTRACT: The present work investigates the molecular generator as autovibrating system with one degree of freedom which can be described by the equation by N. G. Basov and A. M. Prokhorov (ref. 1) for steady vibrations. The equation of the vibrations of the molecular generator can be put down in general form as a system of equations: $L_k(E + 4\pi\sigma) = 0$; $L_m(E) = \sigma$. E denoting the field strength at the edge of the generator and σ the polarization of the molecules. The first of these equations is an usual circuit differential equation and the second equation is the equation of the molecular system. The problem of forming the second equation is very complicated and not yet solved at present. Some problems of the theory of the

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A Contribution to the Theory of the Molecular Generator and of the Fluctuations of its Vibrations

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molecular generator, however, can be solved by means of the equation by Basov-Prokhorov (ref. 1). This equation describes the vibrations which became steady and is a contour equation with a complex dielectric constant ε of the molecular bundle. This equation can be obtained from the above mentioned system when as second equation the known ratio $E(\varepsilon - 1)/4\pi = \sigma$ is chosen. This equation is valid only for sinosoidal vibrations in the investigated case because of the saturation effect. The fluctuations of amplitude and frequency in the molecular generator are caused by the thermal background noise $\xi(t)$. The equation taking into account these fluctuations is put down here. The taking into account of the occasional dependence of the dielectric constant on t supplies the fluctuation-dependent electromotive forces which even with T=0 are neglectably small compared with ξ (T). The parametric influence of fluctuations, however, is maintained and is also considered here; the corresponding equation and an Anset of the solution for it are put down. Then equations for the short effect of the dielectric constant as well as for the tuning frequency of the circuit are put down. Then the fluctuations of the amplitude and of

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A Contribution to the Theory of the Molecular Generator and of the Fluctuations of its Vibrations 56-2-17/51

the phase of vibration are determined. According to the formula given here the fluctuations of the frequency of the molecular generator are the 10^6th to 10^8th part of the fluctuations connected with the fluctuation background noises in an equivalent valve generator. The monochromatism and the stability of the vibrations of the generator can be explained by the automatic control of the frequency. There are 7 references, 6 of which are Slavic.

ASSOCIATION: State University, Gor'kiy (Gor'kovskiy gosudarstvennyy universitet)

SUBMITTED: July 5, 1957

AVAILABLE: Library of Congress

1. Generators-Molecular-Vibration-Theory

Card 3/3

Troitskiy, V.S.

05477

SOV/141-2-2-2/22

AUTHORS: Tz Lang-yao, Malakhov, A.N., Plechkov, V.M. Razin, V.A. Rakhlin, V.L. Stankevich, K.S. Strezhneva, K.M. T'ang Shou-p'o, Troitskiy, V.S. Khrulev, V.V. and Tseytlin, N.M.

TITLE: Observations of the Annular Solar Eclipse of April 19, 1958 on Wavelengths of 1.63, 3.2 and 10 cm

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1959, Vol 2, Nr 2, pp 154 - 158 (USSR)

ABSTRACT: The report of a joint Soviet-Chinese expedition to Ling-sui (φ = 18°30'32", L = 110°01'12") on the island of Hai-nan. The aerials used parabolic reflectors of diameters 1 m at the shorter wavelengths and 1.5 m at the longest. The fluctuations in the threshold of sensitivity were similarly 4°, 5° and 4°. The electrical axes of the aerials were parallel to one another. The absolute accuracy of intensity measurement was ± 15% at the longer wavelengths and ± 20% at the shortest. The relative accuracy, assuming an averaging period of 1 min, was 2-3%. The results are shown in Figure 1 as a percentage of the effective temperature expressed as a percentage of the

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temperature of the uneclipsed sun. The values of the latter were 9 000 °K (1.63 cm), 21 000 °K (3.2 cm), 100 000 °K (10 cm). The vertical lines on the diagram represent the instants of disc "contact" (4 in number) and the occultation of certain well-known spots Nrs 188 and 186. A number of peculiarities may be noted. Between $2^h 0.3^m$ and $2^h 15^m$ and between $3^h 47^m$ and $3^h 58^m$ there is an increase in intensity over what might be expected. Figure 2 shows a synoptic chart of the sun. If the Nr 188 group of spots measures 3' x 1' the effective temperature (5.10^4 °K at 1.63 cm) and height 0.04 R at 10 cm) may be estimated. The curves for 3.2 cm and 10 cm in Figure 1 are asymmetrical. This may be explained as due to a wedge-shaped equatorial region which increases in brightness towards the eastern limb of the sun. The longer wavelength curves also show a small "hump" in the trough. This is due to "limb brightening" and it is possible to estimate its amount - e.g. at the

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shortest wavelength the annulus contributes 4.5% of the intensity of the uneclipsed sun. The effective radius of the "radio-sun" is also estimated as about 4% (depending on wavelength) greater than the optical radius. The deduced values of various constants are in Table 1. The AS.WR.of China are thanked as are also Chang Li-hsin, Hsu Yuan, Li Chi-wen. The Ac.Sc.USSR are thanked, also A.P. Molchanov, B.M. Budkin, P.P. Lugovenko and A.A. Mel'nikov. There are 2 figures, 1 table and 2 Soviet references.

ASSOCIATION: Issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Radiophysics Research Institute of Gor'kiy University)

SUBMITTED: December 9, 1958

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SOV/141-2-3-6/26

9,4000

AUTHOR: Troitskiy, V.S.

TITLE: The Influence of Spontaneous Radiation on the Spectral Line Width of a Molecular Oscillator 25

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1959, Vol 2, Nr 3, pp 377 - 383 (USSR)

ABSTRACT: The paper was presented at the First All-Union Conference on Statistical Radio-physics, Gor'kiy, 1958.
It is shown that the line width has two components. One is due to noise in the oscillator circuit (thermal width); the other is due to spontaneous radiation of the molecules. The latter is of the same order of magnitude as that associated with an isolated molecule and is the essential threshold of monochromatic oscillations. The problem has not yet been solved rigorously in quantum-mechanical terms but the present estimate should be useful as a guide to experiments. It is assumed that the oscillator is connected to the load through a circulator. Both the amplitude and frequency of the oscillator will influence the random component of output and the general equation, taking into account both thermal and radiation fluctuations, is (1),

$$d^2(V_\varepsilon)/dt^2 + (\omega_0/Q_{11})[d(V_\varepsilon)/dt] + V\omega_0^2 = \omega_0^2(\xi_K + \xi_{cn}),$$

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The Influence of Spontaneous Radiation on the Spectral Line Width of a Molecular Oscillator

where: $V = a_o \cos \omega_1 t$ is the voltage across the circuit;

ω_o is the natural frequency of the circuit itself;

ω_1 is the mean frequency of steady-state oscillations;

$\xi_K(t)$ is the thermal noise emf due to the total resistance of the circuit and load;

Q_H is the Q-factor corresponding to the latter resistance,

$\varepsilon = \varepsilon' - i\varepsilon''$ is the complex permittivity of the gas used (which depends on the amplitude and frequency of oscillations near the transition frequency ω_2) and

$\xi_{cn}(t)$ is the emf equivalent of the spontaneous radiation.

It is also apparent that the radiation component of width is not less than $1/\pi\tau_o$, where τ_o is the most probable

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67529

SOV/141-2-3-6/26

The Influence of Spontaneous Radiation on the Spectral Line Width of a Molecular Oscillator

flight-time of a molecule in the circuit. The effect of including a circulator is to make the thermal noise spectrum a function of the generator circuit only. The magnitude of the dielectric constant ϵ of the gas being used depends on the number of molecules in the circuit and their velocity-distribution. Suitable expressions substituted in Eq (1) produce Eq (2). The fluctuations in amplitude and phase are given in Eq (5), whence it is shown that the discrete nature of the molecular beam does not influence the fluctuations in frequency. The spectral density of the fluctuations is given in Eq (8). Interest is confined to the low-frequency part of the fluctuation spectrum and a simple (comparatively) expression for line width (Eq (12)) in terms of the spectral density of the spontaneous-radiation component is derived. The distribution function assumed is that of Eq (13). It is postulated that the effective total power is related by a single coefficient to the non-coherent power, $M\Gamma_0\hbar\omega_2$, of spontaneous 4

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67529

The Influence of Spontaneous Radiation on the Spectral Line Width of a Molecular Oscillator SOV/141-2-3-6/26

radiation by the molecules in the circuit in the absence of generation (Γ_0 is the single-molecule radiation probability, N the total number of excited molecules). Substituting typical values into Eq (12) gives a thermal width of 10^{-5} c/s and a radiation width of 0.5×10^{-5} c/s. There are 7 references, 5 of which are Soviet and 2 English.

ASSOCIATION: Issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Radiophysics Research Institute of Gor'kiy University)

SUBMITTED: December 30, 1958

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Card 4/4

67544

3.1700

SOV/141-2-3-22/26

AUTHORS: Zelinskaya, M.R., Troitskiy, V.S. and Fedoseyev, L.N.

TITLE: Radio Emission of the Moon on 1.63 cm during 1956-1957

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1959, Vol 2, Nr 3, pp 506 - 507 (USSR)

ABSTRACT: The authors have measured the effective temperature of the central part of the lunar disc as a function of its phase. The results obtained can be approximated by the expression:

$$T_{\Omega} = 224^{\circ} - 36^{\circ} \cos (\Omega t - 40^{\circ}) \quad (1)$$

(in the case of new moon $\Omega T = 0$) while the corresponding theoretical function (Ref 2) is:

$$T_{\Omega} = 204 - 133^{\circ}(1 + 2\delta + 2\delta^{2})^{-1/2}\cos (\Omega t - \xi) \quad (2)$$

where $\delta = \beta/\varkappa$ is the ratio of the penetration of the electromagnetic wave $1/\varkappa$ to the depth of penetration of the thermal wave $1/\beta$ (β and $\varkappa$ are the attenuations

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of the thermal and electromagnetic waves in the lunar rock, which depend on the physical and chemical characteristics of the material on the lunar surface) and

$$\mathrm{tg}\,\xi = \delta/(1 - \delta) \qquad (3).$$

The magnitude of the constant component agrees with the theoretical constant component to within the limits of experimental error. The value of δ, calculated from Eqs (1) and (2) turned out to be 2.3 ± 0.2. The value of ξ calculated from Eq (3) is 35°, while the experimental value is $40 \pm 7^\circ$. Table 1 gives a comparison of results obtained on other wavelengths. Using the results obtained for wavelengths of 1.25, 1.63 and 3.2 cm. it is possible to derive the interesting relation:

$$\delta/\lambda \approx \mathrm{const}. \qquad (4).$$

It is known that such a relation is a result of the fact

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Radio Emission of the Moon on 1.63 cm during 1956-1957

that solid dielectrics have a constant loss angle almost in the entire cm region, i.e.

$$\mathrm{tg}\,\Delta = 4\pi\sigma(\omega)/\varepsilon\omega \approx \mathrm{const.} \qquad (5)$$

where $\sigma(\omega)$ is the equivalent electrical conductivity. Using the above value of δ and of the thermal conductivity ($k = 2.5 \times 10^{-6}$) obtained from optical data (Ref 8), it is easy to show that $\varkappa = 0.2\ \mathrm{cm}^{-1}$ and $\sigma = 7.9 \times 10^{8}$ CGSE. This gives the loss angle for lunar rocks as about 2° and the depths of penetration at $\lambda = 1.63$ cm as $1/\varkappa = 5$ cm and $1/\beta = 2.2$ cm. Compared with terrestrial rocks, this value of the conductivity is relatively large but not impossible for rocks with a large content of potassium, sodium and iron oxides. For wavelengths of 8.6, 8 and 1.5 mm, the result given by Eq (4) does not apparently hold as well. Near $\lambda = 8$ mm, σ/λ shows a quasi-resonance behaviour. If this is in fact

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the case, then one must admit the existence of a reduction in $\varkappa$ in lunar rocks for $\lambda = 8$ mm, which is difficult to explain. On the other hand, it might be assumed that the thermal conductivity of the upper layers of the lunar soil (which is mainly responsible for the 8 mm radiation) is lower than the thermal conductivity at greater depths. A similar result may be obtained from the fact that the lag of the radio emission behind the phase of heating on $\lambda = 1.63$ cm turned out to be somewhat larger than required by the single-layer model of the lunar soil, and is in better agreement with the two-layer model. However, available data are not sufficiently accurate for a clear choice between the two models. It is necessary to have higher resolution data in the mm and the cm ranges. There are 1 table and 8 references, 4 of which are English and 4 Soviet.
(This is an abridged translation.)

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Radio Emission of the Moon on 1.63 cm during 1956-1957

ASSOCIATION: Issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Radiophysics Research Institute of Gor'kiy University)

SUBMITTED: February 18, 1959

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9.3260

69950
SOV/141-2-4-5/19

AUTHOR: Troitskiy, V.S.

TITLE: Influence of the Flicker Noise on the Width of an Oscillator Spectral Line 25

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1959, Vol 2, Nr 4, pp573 - 580 (USSR)

ABSTRACT: In an earlier work (Ref 1), the author gave a method of evaluating the influence of periodic noise of the tube on the amplitude and frequency fluctuations in an oscillator. The above method is now applied to the analysis of the fluctuations in a particular type of oscillator. An anode-tuned oscillator whose capacitance is $C(t) = C_0 + \varkappa(t)$ is considered; the component $\varkappa(t)$ is the fluctuating portion of the capacitance such that $\varkappa \ll C_0$ and $\bar{\varkappa} = 0$. The equation for the current in the inductive branch of the resonance circuit, which takes into account the thermal e.m.f. $\xi_0(t)$, is in the following form:

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Influence of the Flicker Noise on the Width of an Oscillator Spectral Line

$$\frac{d^2x}{dt^2} + \left(\frac{r}{L} + \frac{\dot{\varkappa}}{C}\right)\frac{dx}{dt} + \omega^2 x = \frac{1}{L}\frac{d\xi_o}{dt} + \omega^2 J_a(t) \qquad (1)$$

where $\omega^2 = 1/L\,(C_o + \varkappa)$

and $J_a(t)$ is the instantaneous value of the total anode current.

This is given by:

$$"\check{J}_a"(t) = \bar{J}_a(t) + \xi_1(t)\sqrt{\bar{J}_a\gamma_1} + \xi_2(t)\bar{J}_a\sqrt{\gamma_2} \qquad (2)\ .$$

The first component of this equation represents the dynamic value of the anode current; the second component gives the shot current and the third represents the

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Influence of the Flicker Noise on the Width of an Oscillator Spectral Line

flicker current of the tube; the coefficients γ_1 and γ_2 are referred to as the depression coefficients and indicate the effect of the noise reduction in the presence of the space charge. Since the flicker noise depends on the fluctuations of the tube slope, one of the ways of estimating its influence on the frequency is to consider the fluctuations of the dynamic capacitance of the tube. The capacitance can be expressed as $\varkappa(t) = \Delta C \sqrt{\gamma_2}\ \xi_2 + \delta C \xi_3$ where ξ_3 is a certain random function having its spectrum in the region of the low frequencies. Eq (1) can therefore be expressed as Eq (4), where the functions in the right-hand side portion of the equation are given on p 575. Eq (4) describes the fluctuations in an oscillator with one degree of freedom. The solution of Eq (4) is assumed to be in the form $x = a \cos \Psi + u_1(a, \Psi)$ where a is the amplitude,

Card 3/6 Ψ is the phase of the oscillations and $u_1(a, \Psi)$ is a

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second-order correction to the solution given by the first approximation. The amplitude can be expressed as $a = a_o(1 + \alpha)$, while the phase may be given by $\Psi = \omega_o t + \vartheta_1 + \varphi(t)$; $\alpha(t)$ and $\varphi(t)$ represent the amplitude and phase fluctuations. The formulae for determining these quantities are given by Eqs (5). If it is assumed that the tube has a cubic characteristic, i.e. $J_a = SV - S_1 V^3$, where S is the slope of the tube and V is the voltage amplitude at the grid, Eqs (5) can be rewritten as Eqs (8). The solution of Eqs (8) is used to evaluate the spectrum of the amplitude fluctuations, $w_a(\Omega)$ and frequency fluctuations $w_\nu(\Omega)$. These quantities are expressed by Eqs (10) and (11), respectively. In the case of a practical oscillator, Eqs (10) and (11) can be simplified and the resulting formulae are in the form of Eqs (12) and (13). These are

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used to determine the frequency fluctuations caused by the flicker noise in a practical circuit having the following parameters:
$f_o = 1$ Mc/s; $Q = 50$; $J_1 = 7$ mA; $J_o = 10$ mA;
$C_o = 200$ pF; $r = 16\,\Omega$ and the oscillator power $P = 1$ W. It is found that the bandwidth of the fluctuation $\Delta F_e = 3.3 \times 10^{-8}$ c/s. If the oscillator considered above contains a quadripole in its grid circuit, such that the phase of the voltage is shifted by a small angle ρ, it can be shown that the flicker noise has no effect on the frequency of the oscillations. The oscillator cannot be considered as an isochronous device. The author expresses his gratitude to A.N. Malakhov for useful discussion and constructive criticism and to S.M. Rytov for reading the manuscript and also to V.N. Nikonov for his help with the calculations.

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SOV/141-2-4-5/19

Influence of the Flicker Noise on the Width of an Oscillator Spectral Line

There are 7 Soviet references.

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Radio-physics Institute of Gor'kiy University)

SUBMITTED: April 10, 1959

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06641

3.1700

S/141/59/002/05/002/026
E192/E382

AUTHOR: Troitskiy, V.S.

TITLE: Influence of the Atmosphere on the Antenna Pattern and the Strength of the Radio Emission Received From Cosmic Sources

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1959, Vol 2, Nr 5, pp 683 - 690 (USSR)

ABSTRACT: The normally recorded antenna pattern of a radio-astronomic equipment is the so-called "cosmic" pattern, which corresponds to a given fixed position of the antenna system relative to the surface of the Earth. However, it is often necessary to determine the pattern of an antenna system consisting of the actual antenna and the Earth in a uniform medium by employing the "cosmic" pattern. For this purpose, it is necessary to know the attenuation function for the radiation flux near the Earth surface. The attenuation can be due to the absorption or to refraction phenomena. The attenuation function caused by the absorption was determined in Ref 1. In the following, an attempt is made to determine the attenuation produced by the refraction during the passage of the

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Influence of the Atmosphere on the Antenna Pattern and the Strength of the Radio Emission Received From Cosmic Sources

radiation through the atmosphere. For the purpose of analysis a spherical coordinate system having its origin at the receiving antenna is chosen. The coordinates of the source are described by the true (ζ) and apparent (z) zenith distances. The space surrounding the source is uniform and has a refractive index n_1. The atmosphere is assumed to be a weakly absorbing, non-uniform medium, having a refractive index $n(1 - i\varkappa)$, which depends on the height; also, $\varkappa^2 << 1$. The complex refractive index of the medium in the vicinity of the antenna is $n_2(1 - i\varkappa_2)$. A pencil of rays issuing from an element normal to the rays of the source surface is $d\sigma_1$; these fall on a perpendicular area s_2 at the Earth surface (see Figure 1). During its passage through the atmosphere, the pencil of rays is refracted and changes its cross-section. Secondly, the atmosphere absorbs

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energy in accordance with $e^{-\gamma(z)}$, where $\gamma(z)$ is the overall optical thickness of the atmosphere. It is shown that the flux passing through s_2 is expressed by:

$$dw = I_1 s_1 d\Omega(\zeta) e^{-\gamma(\zeta)} = I_2 s_2 d\Omega(z) \qquad (2)$$

where $d\Omega(\zeta) = d\sigma_1/r^2$ and $d\Omega(z) = d\sigma_2/r^2$;

these quantities represent the true and the apparent spherical angles of an element at the surface of the source. It is now assumed that the pattern of an antenna situated in a medium near the surface of the Earth is represented by F ; the cosmic diagram is denoted by F_K , while F_{KO} is the cosmic diagram in the absence of atmospheric losses. Now the transition from the coordinates z, φ in the atmosphere to true coordinates ζ, φ is effected by employing: 4

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$$\zeta = z + R(z); \quad z = \zeta - R(\zeta) \qquad (4)$$

where $R(z)$ and $R(\zeta)$ are the refraction coefficients. From the above, it is found that the directivity D_K and the efficiency η_K of the "cosmic" antenna are related to the directivity D of the actual antenna system by means of Eqs (5) and (6). The spectral density can therefore be represented by Eq (8). On the basis of the above, the antenna temperature T_a is expressed by:

$$T_a = \frac{\eta_K}{4\pi} \int\limits_{\Omega_1(\zeta)} T_1(\zeta) D_K(\zeta,\varphi)\, d\Omega(\zeta) =$$

$$= \frac{1}{4\pi} \int\limits_{\Omega_1(z)} T_1(z) e^{-\gamma(z)} D(z,\varphi) d\Omega(z) \qquad (9)$$

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From this it is seen that the strength of the source can be determined either from the "cosmic" antenna pattern and the true dimensions and brightness of the source or from the actual antenna pattern and the apparent dimensions and brightness of the source. It is shown that the spherical angles of the source are expressed by Eqs (11). The function $y = [1 + R'_z(z)]^{-1}$ of Eqs (11) was evaluated for a standard atmosphere having a humidity of 10 g/m^3 and the results are indicated in Table 1 and shown graphically in Figure 2. It is now possible to consider various special cases. If the beam width of the antenna pattern and that of the cosmic antenna are much smaller than the apparent and the true angular dimensions of the source, the antenna temperature can be expressed by Eq (12), where α_K and α are certain constants characterising the influence of the side lobes. When the

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beam width of the antenna is much greater than the angular dimensions of the source, the temperature is represented by Eq (13). From this, it is seen that as the height of the source is increased, the strength of the received radiation decreases proportionately to the change of its apparent dimensions. This attenuation of the received signal can be referred to as the "refraction-type attenuation". On the other hand, it is found that for a point source, the refraction attenuation is always present, irrespective of the width of the radiation pattern. When the width of the pattern is comparable with the angular dimensions of the source, the antenna temperature is given by Eq (15).
There are 2 figures, 1 tables and 5 Soviet references.

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Influence of the Atmosphere on the Antenna Pattern and the Strength of the Radio Emission Received from Cosmic Sources

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Radiophysics Institute of Gor'kiy University)

SUBMITTED: May 12, 1959

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SOV/109-4-1-4/30

AUTHORS: Zhevakin, S. A. and Troitskiy, V. S.

TITLE: Absorption of Centimeter Waves in a Stratified Atmosphere (Pogloshcheniye santimetrovykh voln v sloistoy atmosfere)

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 1, pp 21-27 (USSR)

ABSTRACT: The article gives complete formulae for the evaluation of the absorption in the atmosphere, which take into account the curvature of the Earth and the refraction. The formulae permit the calculation of the absorption for centimetre waves by using the temperature and the absolute humidity at the Earth's surface as the basic data. A path L between points 1 and 2 at heights h_1 and h_2 in the atmosphere is considered (see the figure on p 22). The complete expression for the reflection coefficient at a height h is given by:

$$\varkappa = \varkappa_1 \varphi_1(h) + \varkappa_2 \varphi_2(h) , \qquad (1)$$

where $\varkappa_1$ is the absorption coefficient due to the presence

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of hydrogen and $\varkappa_2$ is the absorption coefficient due to water vapours; φ_1 and φ_2 are functions of height such that $\varphi_1(0) = \varphi_2(0) = 1$ and $\varphi_1(\infty) = \varphi_2(\infty) = 0$. The absorption in an element of length $d\ell$ is equal to $e^{-\varkappa(h)d\ell}$, so that the total absorption is expressed by Eq.(2), where J and J_0 are field intensities at any point in the presence of absorption and in the absence of absorption, respectively. Since $d\ell$ can be expressed by Eq.(5), where n_1 is the refraction coefficient at point 1 and n is the refraction coefficient at a given point of the path L, the total attenuation coefficient for the wave can be written in the form of Eq.(6). This can also be written as Eq.(7), where quantities ℓ_1 and ℓ_2 are expressed by Eqs.(8). The quantities ℓ_1 and ℓ_2 denote the effective path lengths in a dry atmosphere and in the presence of water vapours. The pressure and the temperature for the standard atmosphere at a height h can be represented by Eqs.(9). On the other hand, the absolute humidity at a height h is given by Eq.(11)

 where ρ_0 is the humidity at $h = 0$ and H_0 is a

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characteristic quantity for the water vapour which, for the USSR, is equal to about 2.6 km. The absorption coefficient due to the hydrogen is expressed by Eq.(13) where D is a constant, ν is frequency, T is the absolute temperature of the hydrogen, N is the molecular concentration of the hydrogen, $\Delta\nu$ is the width of the absorption line and $\delta = \Delta\nu/c$. For the waves of 1.5 to 10 cm the hydrogen absorption coefficient can be simply expressed by Eq.(14). For the standard atmosphere the function φ_1 can therefore be expressed by Eq.(18). On the other hand, the function φ_2, which takes into account the absorption due to the presence of water vapours, is expressed by Eq.(22). The final expression for the absorption coefficient is therefore given by:

$$\varkappa(h) = \varkappa_1 e^{-\frac{h}{H_1}} + a\rho_0 e^{-\frac{h}{H_2}} , \qquad (24)$$

where H_1 = 5.3 km and H_2 = 2.1 km. The quantities l_1 and l_2 can therefore be expressed by Eqs.(27), provided the simplification defined by Eq.(25) is adopted; a_e in Eqs.(27) denotes the effective Earth radius. The quantity l of Eqs.(27) can be expressed by Eq.(29) or Eq.(30); this can also be written as Eq.(31). Similarly, l_2 can be expressed by Eq.(32). Function f(t) in Eqs.(31) and (32) is evaluated in Table 1. Eqs.(31) and (32) were used to determine l_1 and l_2 for various L , Θ_1 and h_2 . The values obtained are shown in Table 2; these were calculated for H_1 = 5.3 km, H_2 = 2.2 km and a_e = 9000 km. From the table it is seen that the maximum effective path length in a dry atmosphere does not exceed 274 km and that in the water vapour of the atmosphere is less than 176 km. The authors express their gratitude to

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Absorption of Centimeter Waves in a Stratified Atmosphere

N. M. Tseytlin for his help in this work. The paper contains 1 figure, 2 tables and 6 references; 1 reference is English, 1 French and 4 are Soviet.

ASSOCIATION: Radiofizicheskiy institut pri gosudarstvennom universitete im. N. I. Lobachevskogo, g. Gor'kiy (Radiophysics Institute of the State University imeni N. I. Lobachevskiy, in the town of Gor'kiy)

SUBMITTED: May 13, 1957.

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TROITSKIY, V. S. and STREZHNEVA, K. M.

Phase Characteristics of Lunar Radiation of 3.2 cm Wave.

report presented at the International Symposium on the moon, held at the Pulkovo Observatory, Leningrad, USSR, 6-8 Dec 1960.

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S/141/60/003/004/011/019
E192/E382

AUTHORS: Troitskiy, V.S. and Tseytlin, N.M.

TITLE: Method of Measuring the Scattering Coefficient and Background Noise of Antennae. Absolute Measurement of the Background Brightness at Ultrahigh Frequencies

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1960, Vol. 3, No. 4, pp. 667 - 671

TEXT: The conditions of measuring the background are first considered. It is assumed that the space surrounding the antenna is for a given wave characterised by a brightness temperature distribution $T(\varphi, \psi)$, which should be measured by means of a radiometer having a radiation pattern $F(\varphi - \varphi^o, \psi - \psi^o)$ where φ^o and ψ^o are the azimuth and the height of the main beam of the antenna. The noise at the output of the antenna is given by:

$$T_a(\varphi^o, \psi^o) = \bar{T}_{\Gamma\Pi}(\varphi^o, \psi^o)\eta(1 - \beta) + \bar{T}_{\text{Б}}(\varphi^o, \psi^o)\eta\beta + T_o(1 - \eta) \quad (1)$$

where η is the efficiency of the antenna,
$T_o(1 - \eta)$ is the internal noise of the antenna and

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T_o is the temperature of the body of the antenna. The temperatures $\bar{T}_{гл}$ and $\bar{T}_б$ are defined by Eqs. (2) and represent the average intensity of the background contained in the main lobe and all the remaining lobes of the antenna, respectively; the parameter β in Eq. (1) represents the portion of the power radiated in the side lobes of the antenna. The first term of Eq. (1) represents the noise received by the main lobe of the antenna pattern, while the second term gives the power of all the remaining lobes. When measuring the background brightness it is necessary to determine the first term of Eq. (1). However, in order to avoid errors, it is necessary that the quantity $T(\varphi, \psi)$ be constant within the limits of the main lobe. The method proposed consists of measuring the radiation from three definite

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calibrating regions which can be arbitrarily situated in space. The true zenith is chosen as one of these calibration directions. The second direction is represented by the zenith "reflected" into the antenna by means of a flat mirror; the third direction is obtained by directing the antenna onto an absolutely dark surface situated together with the flat mirror and having a temperature T_o. Both surfaces are situated at the horizon level. The antenna noise temperature, when its main lobe is directed towards the zenith (φ_1, ψ_1), is given by Eq. (3). The noise temperature at the output of the antenna when it is directed onto a reflecting surface $(\varphi_2$ and $\psi_2)$ is given by Eq. (4), while the noise temperature, when the antenna is directed onto an absorbing surface having the same coordinates φ_2 and ψ_2, is defined by Eq. (5),

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where $\bar{T}_{\Gamma\Sigma}$ and $\bar{T}_{б}$ are determined from Eq. (2). Finally, the main lobe is directed towards the region whose temperature is to be determined (coordinates φ_x and ψ_x) ; the temperature is now given by Eq. (6). From Eqs. (4) and (5) it follows that ΔT_{32} is given by Eq. (7), from which it is possible to determine $\eta(1 - \beta)$; this is given by Eq. (8). The temperature $\bar{T}_{\Gamma\Pi_x}$ is therefore given by Eq. (11). All the quantities in this equation are known except Δ ; however, in most cases, Δ can be neglected. In order to determine the background noise it is necessary to introduce an additional measurement, namely, the noise at the output of the antenna is compared with the noise of a black body, which is substituted for the antenna. The temperature of the black

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Method of Measuring the Scattering Coefficient and Background Noise of Antennae. Absolute Measurement of the Background Brightness at Ultrahigh Frequencies

body is T_o. By employing this measurement it is possible to determine approximately the quantity η (Eq. 14). It is then possible to determine β_1 and a more accurate value of η. Finally, $\bar{T}_{б1}$ and $\bar{T}_{б2}$ can be found. From these, it is possible to determine the magnitude of the background noise. By employing the above method, η and β were measured for a 4 m paraboloid provided with a waveguide radiator. It was found that $\eta = 0.85$ and $\beta = 0.34$. The quantity β was also determined by a different method and it was found that the two values were in good agreement.
There are 3 references: 2 Soviet and 1 English.

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S/141/60/003/004/011/019
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Method of Measuring the Scattering Coefficient and Background Noise of Antennae. Absolute Measurement of the Background Brightness at Ultrahigh Frequencies

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Radiophysics Institute of Gor'kiy University)

SUBMITTED: March 17, 1960

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21182

S/141/60/003/006/022/025
E032/E114

3,1550 (1057,1062,1129)

AUTHORS: Troitskiy, V.S., and Tseytlin, N.M.

TITLE: A Method of Measuring the Dielectric Constant of Lunar Soil

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1960, Vol.3, No.6, pp. 1127-1128

TEXT: The dielectric constant of lunar soil has only been measured at optical frequencies using observed values of Brewster's angle for reflected solar light. Owing to the irregularity of the surface under investigation, the angle cannot be determined very accurately, and the dielectric constant is found to lie between 2 and 2.5. The present authors suggest that the larger radio telescopes which are now available should be used to study the polarization of the radio emission of the moon. Such measurements could be used to determine the dielectric constant of the lunar medium at radio frequencies. The method suggested by the present authors consists in the measurement of the radio brightness for the horizontally and vertically polarized radiation from a chosen part of the lunar surface. If φ, ψ

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S/141/60/003/006/022/025
E032/E114

A Method of Measuring the Dielectric Constant of Lunar Soil

are the selenographic coordinates of the chosen region, then

$$T_{\uparrow} = T_{cp}(\varphi, \psi) \left[1 - R_{\uparrow} (\varepsilon, \alpha)\right] \quad ;$$
$$T_{\rightarrow} = T_{cp}(\varphi, \psi) \left[1 - R_{\rightarrow} (\varepsilon, \alpha)\right] \quad ;$$

where $T_{\uparrow}$ and $T_{\rightarrow}$ are the brightness temperature of the surface for the vertically and horizontally polarized radiation respectively, $R(\varepsilon, \alpha)$ is the reflection coefficient, α is the angle between the line of sight and normal to the surface, and $T_{cp}(\varphi, \psi)$ is the average temperature of the surface layer. Since the loss angle of the lunar soil is relatively low (Ref.1), the reflection coefficient R may be calculated from the Fresnel formulae. Fig.1 shows calculated values of $T_{\uparrow}/T_{\rightarrow}$ as a function of α for various values of the average dielectric constant in range 1.2 - 5. The distance of the region under investigation from the limb of the lunar disc is indicated below the horizontal axis. It is clear from this figure that regions in the neighbourhood of the limb are the most suitable. The knowledge of the

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A Method of Measuring the Dielectric Constant of Lunar Soil

optical and radio values for the dielectric constants may be used to obtain information about the density of the surface material. The above discussion strictly applies only to the case of specular reflection. In reality, the reflections will be appreciably non-specular and the results will depend on the "roughness" of the surface. However, 8 mm experimental data (Ref.2) indicate that even in this wavelength region the specular effect is quite appreciable.
There are 1 figure and 2 Soviet references.

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete
(Scientific Research Radiophysics Institute of the Gor'kiy University)

SUBMITTED: July 14, 1960

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21183

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A Method of Measuring the Dielectric Constant of Lunar Soil

Fig.1

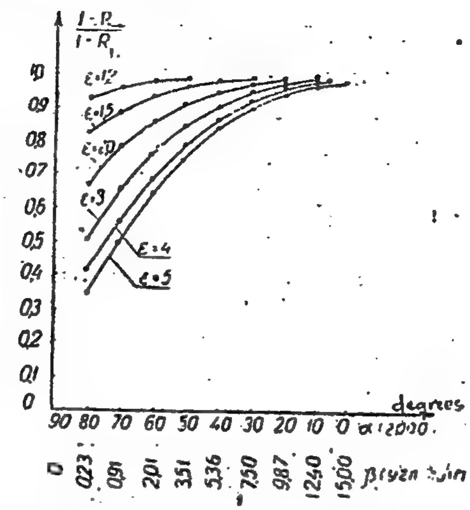

Рис. 1:

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S/751/61/000/008/002/005

AUTHOR: Troitskiy, V. S.

TITLE: Radio emission from the moon, the physical state and nature of its surface

SOURCE: Akademiya nauk SSSR. Komissiya po fizike planet. Izvestiya, no. 3. Kharkov, 1961, 16 - 30.

TEXT: Investigations of the radio emission from the moon, made at 0.4 and 3.2 cm wavelengths, it is shown the results do not agree with the prevalent model of the moon's outer crust, supposedly consisting of a thin non-heat-conducting layer covering the moon's rocks and transparent to radio waves. The character of the wavelength dependence of the radio emission from the moon indicates that the outer crust is quasi-homogeneous to a depth of at least one meter. The previously obtained relation $l_e = 2\lambda l_t$ is confirmed over a wider wavelength range. (l_e and l_t are the depths of penetration of the electromagnetic and thermal waves, respectively, and λ is the wavelength). Analysis of the dependence of l_e on λ leads to the conclusion that the average composition of the lunar surface

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Radio emission from the moon

S/751/61/000/008/002/005

is analogous to the average composition of earth rocks, and the moon's rocks cannot contain any appreciable admixtures of powdered metal such as meteoric iron. It is shown that a quantity proportional to the square root of the permittivity and to the loss angle, and inversely proportional to the density, can serve as a convenient gauge for comparing the electric properties of earth and moon rocks. Comparison leads to the conclusion that the moon's rock is quite porous (density 0.5 g/cm^3) and its dielectric constant is about 1.5. The radio data also indicate that the moon's noon and midnight temperatures are 423 and 133° K, respectively. Another characteristic of the moon's surface is the quantity $\gamma = (k\rho c)^{-1/2}$, where k is the heat conductivity of the moon's rock, ρ its density, and c the specific heat. The value of γ of the moon's surface is estimated to be 900. There are 4 figures and 1 table.

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut Gor'kovskogo universiteta (Scientific Research Radiophysics Institute of the Gor'kiy University)

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S/141/61/004/003/001/020
E133/E435

3,1710

AUTHORS: Troitskiy, V.S., Tseytlin, N.M.

TITLE: Radioastronomical methods of measuring signal intensities and of calibrating antennae and radio-telescopes in the centimetre band

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1961, Vol.4, No.3, pp.393-414

TEXT: This is a general review of accurate absolute methods for measuring signal intensities as is necessary, for example, in radio astronomy. The authors divide the methods into two groups. In the first, the calibration is by the internal noise of the antenna system. In the second, it is by an external radiation source (e.g. a black body). A "black body" in this context can mean an absorbing screen or a region of soil, woods or sea. The authors consider the Moon to be the best "black body" to use; particularly if highly directional antennae are employed. They believe that the use of a "black body" together with a reflecting mirror is superior to the use of the internal noise of the antenna. This is because the former method not only permits the

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Radioastronomical methods ...

measurement of the radiation intensity but also of the overall absorption in the antenna system. It is also unnecessary to consider the background radiation with this method. On the other hand, it is simpler, in practice, to use the internal noise. This method also permits the measurement of the scattering factor. The authors suggest that the following investigations should be made in order to increase the accuracy of calibrating radio-telescopes in the centimetre band. (a) Study of the radio brightness of various soils etc. (b) Calibration of radio sources of small angular diameter. (c) Further investigation of the distribution of radio brightness across the lunar disc, and its phase dependence at centimetre wavelengths. (d) Investigation of methods of measuring the background radiation in the side-lobes. (e) Theoretical and experimental investigations into the use of a reflecting mirror and a black body in calibration.
The authors consider the following methods of calibration in the main body of the text:
(1) by the internal noise, with the antenna directed towards the zenith (e.g. Ref.7: V.S.Troitskiy, Radiotekhnika i elektronika, 2,
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Radioastronomical methods ...

935, (1957); (2) using an absorbing screen (Ref.6: N.L.Kaylanovskiy, M.T.Turusbekov, S.E.Khaykin, Transact. of the Fifth Conference on the Problems of Cosmogony. Izd. AN SSSR, M., 1956, p.347); (3) using radiation from an absorbing material (Ref.8: R.Whitehurst, J.Copeland, F.Mitchell, Proc. IRE, 45, 1410 (1957); R.Whitehurst, F.Mitchell, Bull. Amer. Phys. Soc., 2, 282 (1957)); (4) using the radio emission from a wood (Ref.13: P.Mezger, Z. fur Astrophysik, 46, 234 (1958); Z. fur angewandte Physik, 11, 41, (1959); Telefunken Zeitung, 32, Heft 124, June 1959); (5) by several connected methods described in Ref.15 (V.S.Troitskiy, N.M.Tseytlin, Izv. VUS Radiofizika, 3, 667, (1960)) (e.g. measuring the dielectric constant of the soil).
Three methods of measuring the intensity of radio emission from the Sun and the Moon are also described.
1. Comparison of radio emission from the Sun and the Moon (e.g. Ref.27: M.R.Zelinskaya, V.S.Troitskiy, Transact. of the Fifth Conference on the Problems of Cosmogony. Izd.AN SSSR,M.,1956,p.99).
2. Comparison of solar and lunar emission with that of an artificial "Sun" and "Moon" (e.g. Ref.16: A.P.Molchanov, Izv. VUZ

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Radioastronomical methods ...

Radiofizika, 3, 722 (1960)). These are calibrated sources, which are reflected into the apparatus by plane mirrors of the correct angular dimensions.
3. Measurement of the intensity from the Sun, the Moon and discrete sources with the aid of an absorbing disc of small dimensions (Ref.30: V.D.Krotikov, V.A.Porfir'yev, V.S.Troitskiy, Izv. VUZ. Radiofizika (in press)).
There are 30 references: 19 Soviet and 11 non-Soviet. The four most recent references to English language publications read as follows:
W.Medd, A.Covington, Proc. IRE, 46, 112 (1958);
R.Coates, Proc. IRE, 46, 122 (1958);
J.A.Roberts, G.J.Stanley, Publ. Astr. Soc. Pacific, 71, 485 (1959);
J.Aarons, W.Barron, J.Castelly, Proc. IRE, 46, 325 (1958).

B

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Institute for Radiophysics at Gor'kiy State University)

SUBMITTED: November 5, 1960

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APPROVED FOR RELEASE: 03/14/2001 CIA-RDP86-00513R001756720004-9"

30761
S/141/61/004/003/012/020
E192/E382

9,2574 (1155,1163)

AUTHORS: Troitskiy, V.S. and Tsaregradskiy, V.B.

TITLE: Noise in a two-level excited medium

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, v. 4, no. 3, 1961, 508 - 514

TEXT: A maser based on a dielectric which is in the form of an excited medium can be represented by means of an inductance and a capacitance with the excited medium. It is important to determine the spectral density of the noise generated in the active medium in the equivalent capacitance. This has been done by several authors (Ref. 1 - M.W. Muller, Phys. Rev., 106, 8, 1957; Ref. 2 - R.V. Pound, Ann. Phys., 1, 24, 1957) but it appears that an exact derivation of the Callen-Welton formula for a stationary excited medium would be highly desirable; in particular, it would be important to determine the limits of applicability of the formula for evaluating the noise in masers. It is assumed that the external force acting on the system is:

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E192/E382

Noise in a ....

$$V = V_o \sin(\omega t) = \frac{1}{2}\left[\tilde{V}_o e^{-i\omega t} + \tilde{V}_o^* e^{i\omega t}\right]; \quad \tilde{V}_o = iV_o \ .$$

Further, the system is assumed to consist of N_+ molecules at the upper level and N_- molecules at the lower level. The distances between the molecules in the system is such that there is no correlation during radiation or absorption of the individual molecules; in other words, their radiation is non-coherent. The Schroedinger equation for the wave function ψ can be written as:

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$$i\hbar \frac{\partial \psi}{\partial t} = \hat{H}_o \psi + V_o \sin(\omega t)\, \hat{Q} \psi \qquad (1)$$

where $\hat{H}_o$ is the non-perturbed Hamiltonian of the system,
$V\hat{Q}$ is the perturbation Hamiltonian and
$\hat{Q}$ is the characteristic operator of the medium.

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Noise in a two-level ....

In the absence of perturbation, the eigen values E_n of the energy of the system are:

$$H_o \psi_n = E_n \psi_n .$$

In cases of practical interest, the energy levels E_n of the system have a fully determined width. The average power absorbed by the system can be represented by: (4)

$$P(\omega) = \frac{\pi\hbar\omega V_0^2}{2\hbar} \int_{E_{n\alpha}} f(E_{n\alpha})\, \rho(E_{n\alpha}) \{ |\langle E_{n\alpha} + \hbar\omega | \hat{Q} | E_{n\alpha} \rangle|^2 \rho(E_{n\alpha} + \hbar\omega) - |\langle E_{n\alpha} - \hbar\omega | \hat{Q} | E_{n\alpha} \rangle|^2 \rho(E_{n\alpha} - \hbar\omega)\}\, dE_{n\alpha}$$

where $\rho(E_{n\alpha})$ is the density of the initial states $E_{n\alpha}$. Since (6),

$$C_-/N_+ = C_+/N_-$$

the average power can be expressed by: (7)

$$P(\omega) = \hbar\omega C_+ (1 - N_+/N_-)$$

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where C_+ and C_- are defined by:

$$C_+ = \frac{\pi V_0^2}{2\hbar}\int_{E_{n s}} f(E_{ns})\,\rho(E_{ns})\,|\langle E_{ns}+\hbar\omega|\hat{Q}|E_{ns}\rangle|^2\,\rho(E_{ns}+\hbar\omega)\,dE_{ns}; \quad (5)$$

$$C_- = \frac{\pi V_0^2}{2\hbar}\int_{E_{ns}} f(E_{ns})\,\rho(E_{ns})\,|\langle E_{ns}-\hbar\omega|\hat{Q}|E_{ns}\rangle|^2\,\rho(E_{ns}-\hbar\omega)\,dE_{ns}.$$

On the other hand, the power absorbed from the field can be expressed by the response of the system to the perturbing signal. The presence of the perturbation modifies the operator $\hat{Q}$ in the following manner:

$$\hat{Q} = \frac{1}{2}\left(\alpha\tilde{V}_o e^{-j\omega t} + \alpha^* \tilde{V}_o^* e^{i\omega t}\right) \quad (8)$$

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Noise in a two-level ....

where $\alpha = \alpha' - i\alpha''$, which is a coefficient characterising the system. The change of the internal energy U of the system can now be expressed in terms of α, so that:

$$\alpha''(\omega) = \pi\left(1 - \frac{N_+}{N_-}\right)\int_{E_{n\alpha}} f(E_{n\alpha})\rho(E_{n\alpha})\left|\langle E_{n\alpha} + \hbar\omega\right|\hat{Q}\left|E_{n\alpha}\rangle\right|^2 \rho(E_{n\alpha} + \hbar\omega)\, dE_{n\alpha} \qquad (10).$$

While the average value of the operator $\hat{Q}$ is zero, its mean square value is not equal to zero, even in the absence of the external signal. It is shown that the mean square value of $\hat{Q}$ is given by:

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Noise in a two-level ....

$$\overline{\Lambda}_Q^2 = \int_\omega \frac{\pi}{\hbar} \left[\frac{1 + \frac{N_+}{N_-}}{1 - \frac{N_+}{N_-}} \right] \alpha''(\omega) d\omega \quad (14) .$$

This can also be expressed by:

$$\overline{\Lambda}_Q^2(\omega) = \frac{2\alpha''(\omega)}{\pi\omega} \Theta (\omega, T_{\ni\phi\phi}) \quad (16)$$

where:

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Noise in a two-level ....

$$\Theta(\omega, T_{эфф}) = \frac{\hbar\omega}{2} + \frac{\hbar\omega}{e^{\hbar\omega/kT_{эфф}} - 1} ,$$

in which $T_{эфф}$ is the effective temperature, as defined by:

$$N_+/N_- = e^{-\hbar\omega/kT_{эфф}} \qquad (15) .$$

It is seen from the above that for a medium in thermal equilibrium $T_{эфф}$ is equal to its real temperature and Eq. (16) is then identical with the Callen-Welton formula. Further, the fluctuation-dissipation theorem of Callen and Welton is valid also for non-coherent fluctuations for any distribution of N_+ and N_-. The formulae are used to determine the noise spectral density in a beam-type molecular amplifier. The resonator of the amplifier is represented by a resonant circuit, whose capacitance in the absence of the dielectric is c_0 and

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where the dielectric has a permittivity $\varepsilon = \varepsilon' - i\varepsilon''$. It is shown that the spectral density of the noise is expressed by:

$$\overline{\mathcal{E}^2}(\omega) = \frac{2}{\pi} \frac{\varepsilon''(\omega)}{\omega c_0 |\varepsilon|^2} \Theta(\omega, T_{\text{эфф}}) \qquad (19) .$$

There are 1 figure and 20 references: 12 non-Soviet-bloc and 8 Soviet-bloc (one of the Soviet references is translated from English). The four latest English-language references mentioned are: Ref. 1 - Phys.Rev., 106, 8, 1957; Ref. 3 - J.P. Gordon, L.D. White, Proc. IRE, 46, 1588, 1958; Ref. 5 - J.C. Helmer, M.W. Muller, IRE Trans., M.T.T.-6, 210, 1958. Ref. 4 - M.L. Stich - J. Appl. Phys., 29, 782, 1958.

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Radiophysics Institute of Gor'kiy University)

SUBMITTED: November 12, 1960

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30676

S/141/61/004/004/003/024
E032/E514

3.2500 (1080)

AUTHORS: Strezhneva, K.M. and Troitskiy, V.S.

TITLE: Phase dependence of the lunar radio emission at 3.2 cm wavelength

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1961, Vol.4, No.4, pp.600-607

TEXT: The aim of the present work was to measure the lunar radio temperature at 3.2 cm wavelength as a function of the phase using a more accurate method of measuring the intensity than was done earlier (Ref.1: V. S. Troitskiy and M. R. Zelinskaya, Proceedings of the Fifth Conference on Cosmogony, Izd. AN SSSR, Moscow, 1956, p.99). The antenna was calibrated using the new method described by V. S. Troitskiy and N. M. Tseytlin (Ref.2: Izv. vyssh. uch. zav. Radiofizika, 3, 667, 1960) and the measurements were carried out using the improved apparatus described by V. L. Rakhlin (Ref.3: Pribory i tekhnika eksperimenta (in press)). The paper begins with a discussion of the antenna calibration method described by V. S. Troitskiy (Ref.4: Radiotekhnika i elektronika, 1, 601, 1956; 2, 935, 1957) and A. Ye. Salomonovich

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(Ref.5: Astron. zhurn., 35, 129, 1958). The measurements were carried out during August and October, 1959 and May and September, 1960. The antenna of the radio telescope was in the form of a 4 m paraboloid, the feeder being in the form of the open end of a circular wave-guide. Fig.1 shows the radio temperature as a function of the lunar phase angle. The points represent the temperature in the case of vertical polarization, the crosses represent the temperature in the case of horizontal polarization and the full line gives the weighted average over the lunar disc. As can be seen, the average curve is somewhat asymmetric, although it can be quite well approximated by the formula 4

$$T = 255° + 16° \cos (\Omega t - 50°).$$

This shows that the ratio of the depths of penetration of electromagnetic and thermal waves (V. S. Troitskiy, Ref.8: Proceedings of the Fifth Conference on Cosmogony, Izd. AN SSSR, Moscow, 1956, p.325; Astron. zhurn. 31, 511, 1954) is approximately 7.0 and hence $\delta/\lambda \approx 2.2$. The phase shift in the case of a single layer

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Phase dependence of the lunar ... S/141/61/004/004/003/024
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model should be 41°. This is smaller than the observed value but lies within the experimental error.. Acknowledgments are expressed to N. M. Tseytlin for calibrating the antenna and assistance in the analysis of the results. There are 1 figure and 15 references: all Soviet.

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Radiophysical Institute of the Gor'kiy University)

SUBMITTED: October 21, 1960

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APPROVED FOR RELEASE: 03/14/2001 CIA-RDP86-00513R001756720004-9"

39685
S/141/61/004/004/019/024
E032/E514

3.2500 (1080)

AUTHORS: Krotikov, V.D., Porfir'yev, V.A. and Troitskiy, V.S.

TITLE: Standardization of lunar radio-emission at 3.[illegible] wavelength

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1961, Vol.4, No.4, p.759

TEXT: Present radio-astronomical methods for absolute measurements of centimetre waves do not ensure an accuracy better than 10-15%. The present authors have developed a method for the accurate measurement of the radio emission of the moon and of discrete sources in the centimetre range. The method is a development of the procedure described by V. S. Troitskiy and N. M. Tseytlin (Refs.1 and 2: Izv. vyssh. uch. zav. Radiofizika, 4, 393, 1961; Ibid, 4, 600, 1961), R. N. Whithurst, J. Kopeland, F. H. Mitchell (Ref.3: Proc. IRE 45, 1410, 1957) and A. P. Molchanov (Ref.4: Izv.vyssh. uch.zav., Radiofizika, 3, 722, 1960). It ensures an accuracy of the order of 1%. It has been used in the precision measurement of the radio temperature of the moon at 3.2 cm wavelength. The vertical polarization measurements

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were carried out using a radiometer with a 1.5 m diameter mirror. The sensitivity threshold was 0.2°K at a time constant of 16 sec. The beam width was 1.3° and ensured almost uniform "illumination" of the lunar disc. The radio temperature was therefore practically equal to the average brightness temperature of the disc. The lunar emission was measured by comparing it with two standards, namely, a perfectly black disc with apparent angular dimensions equal to those of the moon, and a further standard in the form of a black plane covering the main lobe and having a central aperture with dimensions equal to those of the lunar disc. Both standards were placed 15-20° above the horizon. Atmospheric absorption and differences in the angular dimensions of the moon and the standards were taken into account. The radio temperature averaged over the disc at 3.2 cm wavelength was found to be

$$\bar{T}_{\lambda} = \frac{1}{\Omega_{\lambda}} \int_{\Omega_{\lambda}} T_{\lambda} \, d\Omega = 210° + 13.5° \cos (\quad t - 55°).$$

The total systematic error is estimated to be less than ± 2.5%.

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Standardizing the radio emission ... S/141/61/004/004/019/024
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It is stated that (with certain improvements) the accuracy can be reduced by a factor of 2. This result was used to compute the brightness temperature at the centre of the disc and the result is $T_{br} = 226°$. The latter is in agreement with the value reported by K. M. Strezhneva and V. S. Troitskiy (Ref.2). Further details will be published later. There are 5 references: 4 Soviet and 1 English (quoted in text).

[Abstractor's Note: Complete translation.]

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ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Radiophysical Institute of the Gor'kiy University)

SUBMITTED: June 23, 1961

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33217

3,1720
3-2500(1080,1395)

S/141/61/004/006/002/017
E032/E114

AUTHORS: Krotikov, V.D., Porfir'yev, V.A., and Troitskiy, V.S.

TITLE: Development of a method for the precision measurement and calibration of the lunar radio emission at $\lambda = 3.2$ cm

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, v.4, no.6, 1961, 1004-1012

TEXT: The method described consists of the comparison of the radio emission of a given source with the thermal radio emission of a perfectly black disc heated to the temperature of its surroundings and placed against the background of the sky at a sufficiently large elevation angle. Since the calibration signal is equal to the difference between the temperature of the disc and the radio temperature of the background at the particular elevation, this method cannot be used at wavelengths beyond the millimetre range while at low frequencies it is limited by diffraction effects. Instead of a disc one can also use an aperture in a black plane. The measurements were carried

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Development of a method for the ... S/141/61/004/006/002/017
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out in two stages. To begin with the artificial moon, i.e. the black disc, is placed in the beam of the antenna and the increase in the antenna temperature at the particular angle is determined. Next, the disc is replaced by a black plane covering the main lobe of the antenna and containing a central aperture equal in diameter to the disc, and the change in the temperature when the disc is inserted into the aperture is determined. Finally, the signal from the moon is recorded in the usual way. Experimental verification of the method showed that it is capable of a 2% accuracy. It is said to be similar to that described by R.N. Whithurst, J. Kopeland and F.H. Mitchell (Ref.3: Proc. IRE, v.45, 1410 (1957)). It was found that the diffraction error which occurs at low elevation angles may be determined and excluded with the aid of a second thermal standard in the form of an aperture in a black plane, or by means of two thermal emitters forming a system of additional screens. The method has been used to determine the average radio temperature of the lunar disc. It was found that the temperature variation is given by (one cycle):

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Development of a method for the ... S/141/61/004/006/002/017
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$$T_{\text{эф}} = 210^{\circ} + 13.5^{\circ} \cos (\Omega t - 55^{\circ}) + 1.7^{\circ} \cos (2\Omega t + 44^{\circ}) + + 0.5^{\circ} \cos (3\Omega t + 11^{\circ}) \text{ (winter months)} \qquad (13)$$

The rms error in the temperature is less than ± 2.5%. The accuracy of the amplitude is better than ± 5%. Acknowledgments are expressed to N.M. Tseytlin and V.A. Razin for discussing the work and criticisms. A.P. Molchanov is mentioned in the article. There are 2 figures, 1 table and 8 references: 7 Soviet-bloc and 1 non-Soviet-bloc. The English language reference reads:
Ref.3: R.N. Whithurst, J. Kopeland, F.H. Mitchell.
Proc. IRE, v.45, 1410 (1957).

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete
(Scientific Research Radiophysics Institute at Gor'kiy University)

SUBMITTED: May 13, 1961

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30825

S/033/61/038/005/015/015
E073/E535

3,1710
3,2560 (1080)

AUTHOR: Troitskiy, V.S.

TITLE: Radio measurements of the dielectric constant and the density of the material of the top layer of the Moon

PERIODICAL: Astronomicheskiy zhurnal, v.38, no.5, 1961, 1001-1002

TEXT: Direct measurement of the dielectric constant of the top layer of the Moon formations is of particular interest, since it would permit determining the density of this layer. Direct measurement of the density could provide an answer on the question whether this layer is a uniform dust or a solid foam. In both cases the nature of the propagation of the radio-waves inside the surface of the Moon (refraction, damping) is determined by the average values of the dielectric constant and permeability of a medium consisting of cavities and a dense crystalline substance. The features of radio radiation of the Moon are determined by the average values of ε and μ and, consequently, only the latter can be measured from radio radiation measurements. The simplifying assumption is made that for a crystalline continuous medium, the permeability $\mu = 1$ and the dielectric constant equals ε_0. The

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dielectric constant ε of a porous material when the crystalline phase is considered as being the basic system and the pores are considered as being inclusions will be :

$$\varepsilon = \varepsilon_o \left(1 - \frac{3\alpha}{\frac{2\varepsilon_o + 1}{\varepsilon_o - 1} + \alpha} \right) \qquad (1)$$

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where $\alpha = 1 - \rho_{av}/\rho_k$ (ρ_{av} - average density, ρ_k - real density). The value ε_o can be taken from data of rocks on the Earth, obtained in the centimetre wave range (Ref.3: V.I.Odelevskiy, Zh.tekhn.fiziki, 21, 667, 1951). This value depends relatively little on the rock and can, therefore, be considered known with sufficient accuracy. Measuring ε and knowing ε_o, the ratio ρ_{av}/ρ_k can be determined and from this the nature of the state of the surface of the Moon can also be determined. For the case that the surface layer is powdery, the formula for ε changes somewhat and according to C.J.F.Bottcher (Ref.5: Theory of Electric

Polarisation, 1952) can be written thus:

$$\frac{\varepsilon - 1}{3\varepsilon} = \frac{\rho_{av}}{\rho_k} \frac{\varepsilon_o - 1}{\varepsilon_o + 2\varepsilon} . \qquad (2)$$

It can be proved that both these formulae reduce into each other with satisfactory approximation. The proposed measurement of ε is based on determining the time lag of the phase of radio radiation from sections of the disc located at various longitudes φ along the equator of the Moon as compared with the phase of heating of the same spot. If $\varepsilon \approx 1$ and the radiation is from a depth ℓ_e for the centre of the disc, then at any longitude the radiation will be approximately from a depth $\ell_e \cos \varphi$. In the neighbourhood of the limb the depth will be small and the phase lag of the radio radiation will be considerably less than for the centre of the limb. If $\varepsilon \gg 1$, the difference in depth between the centre and the limb will be small, due to the intensive refraction of the waves, and the time lag of the radio radiation for the centre and the limb will be approximately equal. According to earlier work

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of the author (Ref.6: Astron.Zh., 31, 511, 1954), the time lag ξ of the first harmonic of the brightness temperature of the radio radiation for points on the equator with a given longitude equals:

$$\mathrm{tg}\,\xi = \frac{\delta \cos \varphi'}{1 + \delta \cos \varphi'} ; \quad \cos \varphi' = \sqrt{1 - \frac{1}{\varepsilon} \sin^2 \varphi} \qquad (3)$$

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where $\delta = 2\lambda$. From this equation we obtain

$$1 - \frac{1}{\delta^2}\left(\frac{\mathrm{tg}\,\xi}{1 - \mathrm{tg}\,\xi}\right)^2 = \frac{1}{\varepsilon} \sin^2 \varphi \qquad (4)$$

By measuring ξ for a number of φ values (for instance 0, 30, 45 and 60°) and constructing a plot of the left-hand part of Eq.(4) as a function of $\sin^2\varphi$, ε can be determined from the angle of inclination of the straight line. It is necessary to take into consideration that seas and mainlands may give differing phase shifts and therefore it is desirable to select for measurement uniform sections. If the measurements are made outside the

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equatorial region. φ in the equation will be the angle of the normal relative to the observer of the lunar area under investigation. The most suitable wave range for such measurements is the millimetre wave range for which the phase shifts are not very large and can be measured with very high accuracy. There are 7 references: 4 Soviet and 3 non-Soviet. The English-language references read as follows: Ref.2: V. W. Hughes Nature, 186, 873, 1960; Ref.5: Quoted in text.

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AUTHOR: Troitskiy, V. S.

TITLE: Mean free path of molecules in a molecular beam

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 2(8), 1961, 389 - 390

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TEXT: The calculation of the mean free path of molecules in beams is significant for molecular generators, since it allows the beam density to be estimated. It is calculated on the assumption that all molecules in the beam travel in the same direction and that collisions with molecules undergoing diffuse scattering during collisions may be neglected. Assuming a Maxwellian velocity distribution of the molecules, the number of collisions is given by $\nu = n\pi\sigma^2\bar{c}(7-4\sqrt{2})/2\sqrt{2} \approx n\pi\sigma^2\bar{c}\cdot 0.475$, where n is the molecular density at the beam point in question, σ is the effective radius of the molecules, and $\bar{c} = 2/\sqrt{\pi\beta}$, $\beta = m/2kT$. Thus, the mean free path (c/ν) at a point with given n is expressed by $\lambda_{beam} \approx 3\lambda_{gas}$, where λ_{gas} indicates the mean free path of the same molecule in the gas. There is 1 Soviet reference.

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Mean free path of molecules ...

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